



Potato Diseases in New Jersey

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SPRAYING WITH A TRACTION SPRAYER.
Good pressure and nozzle arrangement.

NEW JERSEY
AGRICULTURAL EXPERIMENT STATIONS

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NEW JERSEY

AGRICULTURAL EXPERIMENT STATIONS

CIRCULAR 122

POTATO DISEASES IN NEW JERSEY¹

The New Jersey potato crop for 1920 was estimated to be 14,820,000 bushels with an average yield of 156 bushels per acre. In spite of the fact that the crop was larger by approximately 5,000,000 bushels than any previous crop, the growers suffered serious losses from plant diseases, amounting to from 10 to 20 per cent of the entire crop. In some sections of the state late-blight rot did considerable damage, while in others fields were observed where 90 per cent of the crop was unsalable from scab. Tuber-borne diseases, particularly mosaic and leaf roll also were present to a considerable extent and were the causes of a considerable reduction in yield. While it is questionable if all of the losses to the potato crop by diseases could have been prevented, there is no doubt that a knowledge of the appearance of the more important ones, with the measures to be adopted for their control, would have reduced the losses to a considerable extent. The chief aim of this publication is to describe briefly the various diseases that attack the potato and to give the more important facts relative to the nature and control of those which are the causes of the greatest losses. The control measures given have been for most part tried out under New Jersey conditions and found to be satisfactory.

The three chief means of eliminating potato diseases are:

(a) *Planting clean seed.* The necessity of securing potatoes relatively free from disease for seed purposes is now recognized by the grower as being one of the most important of the factors which contribute to success in potato growing. The establishment of seed-potato inspection and certification in the various prominent seed-potato growing sections has been a step in the right direction. The certified seed contains few if any varietal mixture and a minimum amount of disease.

(b) *Seed treatment.* Results of tests conducted in New Jersey as well as in other sections of the United States have demonstrated that seed treatment is an important factor in the reduction of common scab, *Rhizoctonia* and black leg.

¹Prepared February 1, 1921, by Mel. T. Cook, Ph. D., Plant Pathologist, and W. H. Martin, Ph. D., Associate Plant Pathologist, of the New Jersey Agricultural Experiment Station.



Fig. 1. EARLY BLIGHT.

Note the concentric markings of the spots.

(c) *Spraying.* In years when there are outbreaks of late blight or other foliage diseases controlled by spraying there is no question as to the advisability of this treatment.

Early Blight

(*Alternaria solani* E. & M.)

This disease, caused by a fungus, is widely distributed, attacking both potatoes and tomatoes. It first appears as small black spots from $\frac{1}{16}$ to $\frac{1}{4}$ -inch in diameter. These spots enlarge and concentric circles are frequently formed within them (fig. 1). In

advanced stages, the spots frequently unite, sometimes causing the entire leaf to become dry and brittle. Since this disease results in the early death of the plant the tubers are usually smaller than those from healthy plants. Early blight is usually very severe following sun-scald or tip-burn and these troubles very frequently result in reduced yields. The severity of this disease depends largely on the date of its appearance and the rapidity of its development.

Control. Spray with Bordeaux mixture (page 24).

Late Blight

(*Phytophthora infestans* (Mont.) de Bary)

Late blight is caused by a fungus and is probably one of the most destructive of all potato diseases. In some of the important potato-growing states it was responsible in 1920 for losses amounting to from 4 to 5 million dollars. Fortunately, late blight has not been a serious disease in New Jersey. In the past nine years there have been only three outbreaks. In 1918 it was severe in Mercer, Monmouth and Middlesex counties; and in 1919 there was a slight infection on the commercial crop in the central counties with a heavy outbreak on the late crop grown in the southern part of the state, for seed. Again in 1920 it was very severe on the commercial crop in some sections of Monmouth and Mercer counties and on the late crop in the southern part of the state. This outbreak was not as destructive as that of 1919. In case of continued severe outbreaks of this disease the New Jersey growers will be compelled to spray with Bordeaux mixture for its control.

The first indications of late blight are large spots that form on the tips or edges of leaflets (fig. 2). From above these spots appear water-soaked while an examination of the lower surfaces shows a mildew growth; it is here that the fruiting bodies of the fungus are produced. When mature or during dry weather, the spots become dark brown, dry, and brittle. On the tuber the disease appears as dark sunken areas. The flesh beneath the sunken skin is brown and is known to the New Jersey growers as "mahogany rot" (fig. 3). When tubers of this kind are stored the area of brown tissue increases, the color frequently turning to black. If stored under dry conditions the tuber dries up, if stored in a damp place a soft rot frequently appears, due to infection by other organisms.

The disease is especially severe in cool moist weather. Under conditions of this kind, an entire field may wilt and blacken in a few hours. Epidemics of late blight may start from a single hill in a field. The original infection probably starts through planting diseased seed potatoes; weak shoots are formed that rise but a short

distance above the ground and if the weather conditions are favorable, they develop the disease which is rapidly carried to all parts of the field. Tuber infection does not result from the fungus pass-



FIG. 2. LATE BLIGHT.

Tips of leaves killed.

ing down through the stem of the plant but from the washing of the spores from the leaves to the soil where they pass through cracks and come in contact with the tuber which in a short time shows the characteristic rotting. Because of the method of infection

the rotting may first be observed on any part of the tuber. Digging time may afford another occasion for infection. If dug when the vines are wet the tubers are certain to come in contact with late-blight spores with the result that rot will start.

Tubers showing late blight are very often found among seed potatoes brought into the state from the northern potato-growing sections. When planted, these diseased tubers usually do not germinate, or else produce weak plants which give a very poor yield.



Fig. 3. LATE BLIGHT ROT (Mahogany Rot) ON TUBERS

Control. Throw out all infected seed, i. e. tubers showing brown discolorations or mahogany rot when cut. Spray with Bordeaux mixture. No definite spray schedule can be outlined. This must be based largely on local conditions, the point of prime importance being that the applications be made in time. When the disease has become well established in a field spraying is of little value. All the leaves of a plant must be covered with a film of the spray mixture and must be kept covered. The first application should be made when the plants are approximately 8 inches high. Subsequent applications should be made at 10-day intervals. If applied with the proper pressure and nozzle adjustment, this will keep the vines covered. Spraying with 50 to 75 pounds' pressure with only one nozzle to the row will not control late blight. The sprayer used should develop at least 150 pounds' pressure. A traction sprayer fitted with a triplex pump will insure the proper pressure and at the same time will have a lesser tendency to jerk the team and machinery. The proper adjustment of nozzles is of extreme importance. There should be three to each row with one

directed in and slightly upwards from each side and one downward. In case there is a heavy outbreak of late blight late in the season, delay digging until the tops are dead. Never dig when they are wet. Ridging is very often of value in preventing rot. By throwing dirt on the ridge the soil cracks are covered, thus preventing easy access of the spores. The indications are that the organism causing late blight will not live from year to year in the soil, so that there need be no hesitancy in planting potatoes following potatoes killed by the disease.

Tip-Burn (Leaf Hoppers, Sun-Scald)

Tip-burn is most severe during hot weather following prolonged periods of rainfall. The injury usually first appears at the tips or margins of the leaves, which distinguishes it from sun-scald, a trouble produced under similar conditions but which results in the killing of the entire leaf. Until recently the dying of the leaves has been attributed for the most part to these two causes but it has been shown that leaf hoppers are responsible for a large part of the damage. The latter injury may be recognized by the fact that the dead tissue is usually found along the veins whereas tip-burn and sun-scald result in injury to the tissue between the veins. A burning of the foliage similar to that produced by tip-burn or sun-scald may result from applying a liquid spray under a hot sun. The grower should distinguish between sun-scald or tip-burn and the true blights. A study of the accompanying table will show the characteristics which distinguish them from one another.

Control. Spraying with Bordeaux mixture tends to decrease the amount of injury resulting from tip-burn and sun-scald, and at the same time acts as a repellant to leaf hoppers.

Arsenical Poisoning

Spotting and dying of the foliage is frequently caused by the application of Paris green or other arsenical poisons. The injury is usually first observed in the leaf tissues surrounding insect punctures. On the stem it is most severe in the leaf axils or any place where the spray material has collected. While this type of injury is not often severe, it is responsible in some cases for a reduction in the amount of green leaf surface with a corresponding reduction in yield. Additional injury frequently results, in that the killing of the foliage presents conditions favorable for the development of early blight.

Control. Paris green or other arsenical poisons should be mixed with lime whether applied as a dust or in liquid form, except in the case of poisons applied in combination with Bordeaux mix-

ture when no additional lime is necessary. High pressure also will tend to decrease the amount of injury in that there is not a heavy accumulation of the materials at any one point.

COMPARISON OF FOLIAGE DISEASES

Early Blight	Late Blight	Tip-Burn	Arsenical Burns
Caused by a fungus	Caused by a fungus	Caused by weather conditions	Caused by arsenical poisons
Very common in New Jersey	Rare in New Jersey	Very common in New Jersey	Common in New Jersey
Most abundant on late crop	May appear at any time weather is favorable	Any time after the middle of June	Following dust or spray treatments with arsenicals
Starts as small black spots which enlarge	Starts as large water-soaked spots	General dying and drying of leaves but no spotting	Similar to tip-burn but less extensive
Spots within the leaf	Spots may occur on either leaves or stems	Usually on margins or tips of leaves	
Spots become dry and frequently show delicate target circles	Spots show delicate white or pinkish growth on lower side; become brown and dry		

Leaf-Roll

The cause of this disease is not known. It has been common on the Irish Cobbler and Russet varieties for the past five years, frequently causing heavy losses. It can be detected on the younger plants by the rolling upward of the margins of the lowest leaves which are somewhat thicker and more leathery than normal leaves. The tips of the leaves of the older plants are frequently lighter in color and die earlier than normal leaves. The older diseased plant is usually but not necessarily smaller than the normal plant; all the leaves may roll and are likely to be smaller, the color lighter and the entire plant bushy in character (fig. 4). This rolling of the leaves is similar to the condition produced by *Fusarium* wilt and black leg but these troubles should not be confused since a plant infected with leaf-roll does not wilt. Leaf-roll may also be distinguished from these diseases by the fact that if the stem is cut across no internal discoloration will be observed.

Leaf-roll is transmitted by seed so that the tuber is the principal source of infection. The losses due to this disease may be as high as 50 per cent.

Control. The only known method of control is the use of healthy seed. The growers of late-crop seed should take every precaution to eliminate this trouble from the seed plot. A careful inspection of the field should be made when the plants are about six inches in height and again at blossoming time. All plants showing a rolling of the leaves should be considered undesirable and destroyed (page 37).



Fig. 4. LEAF ROLL.
Notice rolling of leaves.

Mosaic

This disease is common to a number of plants and is very severe on potatoes, particularly on the Green Mountain and American Giant varieties. Like leaf-roll its cause is unknown. Leaves of infected plants are usually mottled with light and dark-green areas. As a result of the fact that the dark-green areas grow faster than the lighter areas the leaf is sometimes very much crinkled.

In severe cases the entire plant is dwarfed (fig. 5). Mosaic is carried in the tuber, and planting tubers which carry this disease may result in as much as 50 per cent reduction in yield, depending on the severity of the infection.

Control. The control measures to be followed are the same as outlined for leaf-roll (page 10).



Fig. 5. MOSAIC
Note crinkling of foliage.

Rhizoctonia, Scurf, or Brown Stem

(*Rhizoctonia solani* Kuhn)

This disease is widely distributed and occurs in several different forms known under correspondingly different names as "scurf," "brown stem," "Rhizoctonia," "little potato," "aerial potatoes"

and "rosette." On the tuber, small black spots are formed which will not wash off but which can be scraped off with the finger nail (fig. 6). These black bodies are the resting stage of the fungus and it is by means of these that the disease is carried over from year to year on the seed potatoes.

The organism may exist also in the soil, but its presence there or on the seed potatoes does not necessarily indicate that it will prove a serious disease in the coming crop. The severity of the disease is undoubtedly influenced by soil temperature, moisture and other factors, during the early part of the growing season.



Fig. 6. TUBERS COVERED WITH RHIZOCTONIA SCLEROTIA
The "black specks" do not wash off.

A variety of symptoms may be produced by this disease. The most common forms are the following:

(a) *Poor germination.* Some of the seed pieces fail to germinate, others produce short thick sprouts which never break through the ground. In some cases the tips of the newly formed sprouts are rotted off before they reach the surface (fig. 7). Very frequently when this happens a new sprout starts from below the rotted portion. This may occur several times, finally resulting in a weak hill that will give a very low yield.

(b) *Brown stem and canker.* Where the disease has not been severe enough to kill the young shoot, a browning of the stem may result. These brown areas frequently appear as well defined cankers and may be found on plants of all ages (fig. 8). If the fungus

attacks the plants when young the cankers are frequently severe and the disease very destructive; if the plants are well advanced when attacked the damage is by no means as great.

(c) *Roll leaf*. In the latter part of the season the tips of newly-formed leaves tend to roll in a manner suggesting leaf-roll but can usually be distinguished from it by a characteristic brownish tint, which is especially prominent on the Irish Cobbler and similar varieties.

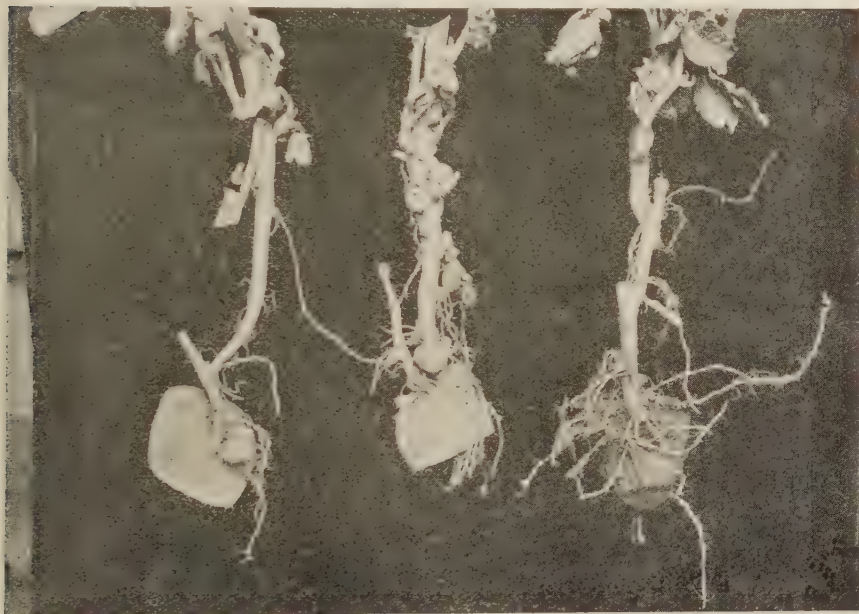


Fig. 7. POOR GERMINATION RESULTING FROM RHIZOCTONIA

(d) *Aerial potato*. Very frequently the stem of an older plant may be completely girdled. This girdling destroys the vessels through which the materials manufactured in the leaves are carried to the tuber. As a result a number of small tubers are formed above the girdled portion (fig. 9).

(e) *Little potato*. Many small potatoes are frequently produced on seriously diseased plants, as many as 45 tubers having been found in a single hill.

Control. Use clean seed if possible. In case the black sclerotia bodies are present treat the seed with corrosive sublimate which, for this disease, has been shown to give much better results than formaldehyde (page 31).

Black Leg

(*Bacillus atrosepticus* Van Hall)

This is a bacterial disease that causes heavy losses in some of the potato-growing sections. It was probably introduced from Europe. In New Jersey plants affected with this disease are usually under-sized and very erect; the leaves are pale in color and tend to curl upward. The stems die from the seed piece upward, turn



Fig. 8. CANKER RESULTING FROM RHIZOCTONIA

black and become dry (fig. 10). The disease also causes a rotting of the tuber (fig. 11), beginning at the point of union of the plant and gradually working inward. Tubers in which the rot is well advanced may be crushed and smeared over sound potatoes and thus spread the disease.

From our present knowledge it is apparent that the disease will not live over in the soil and it is doubtful if it will be carried

from year to year in New Jersey grown seed. While tubers infected with black leg are frequently found in seed from the northern states it is seldom found on home-grown seed. This has resulted



Fig. 9. AERIAL TUBERS CAUSED BY THE GIRDLING OF THE STEMS BY RHIZOCTONIA

from the fact that vines from seed infected with the black-leg organism are usually killed when very immature. Where tubers are formed they usually rot before the crop is dug.

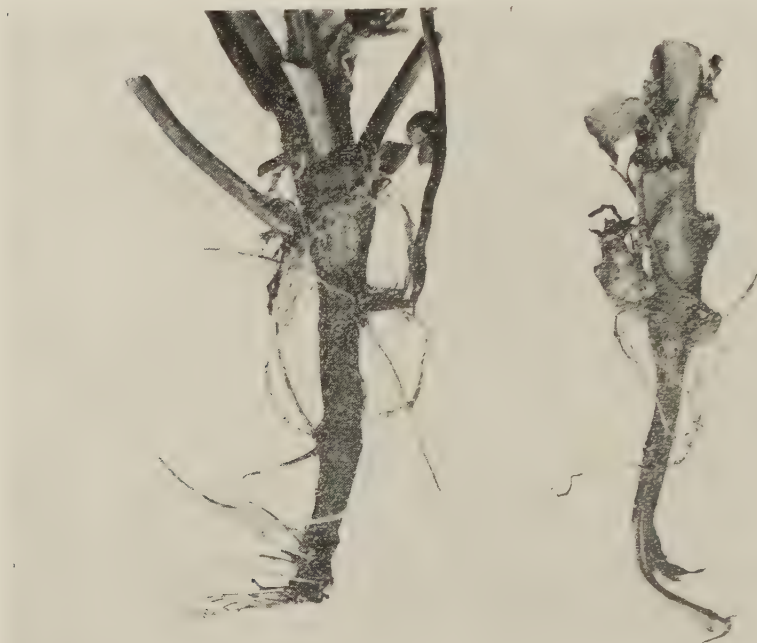


Fig. 10. BLACK LEG ON THE YOUNG VINE.
Note blackened portion at base.

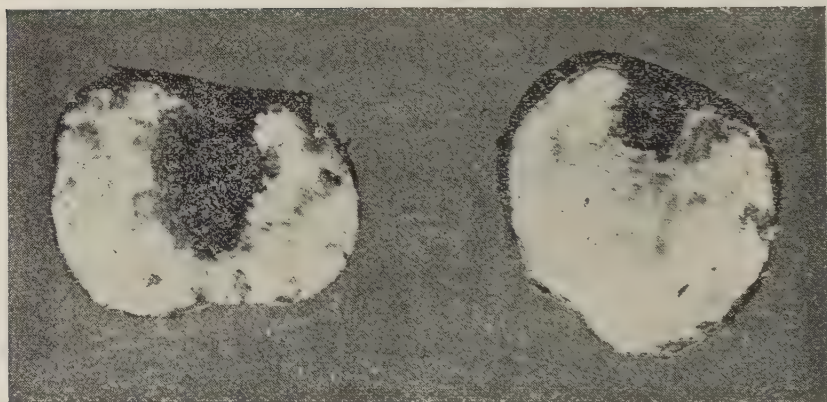


Fig. 11. TUBER ROT DUE TO BLACK LEG.

Control. Throw out all seed tubers that show evidence of the disease. Treat the seed with formaldehyde or corrosive sublimate (page 31).

Fusarium Wilt and Dry Rot
(*Fusarium oxysporum* Schlecht)

This disease, caused by a fungus, has been reported from most of the important potato-growing sections of the country. On the tuber (fig. 12), it causes a dark discoloration starting at the stem

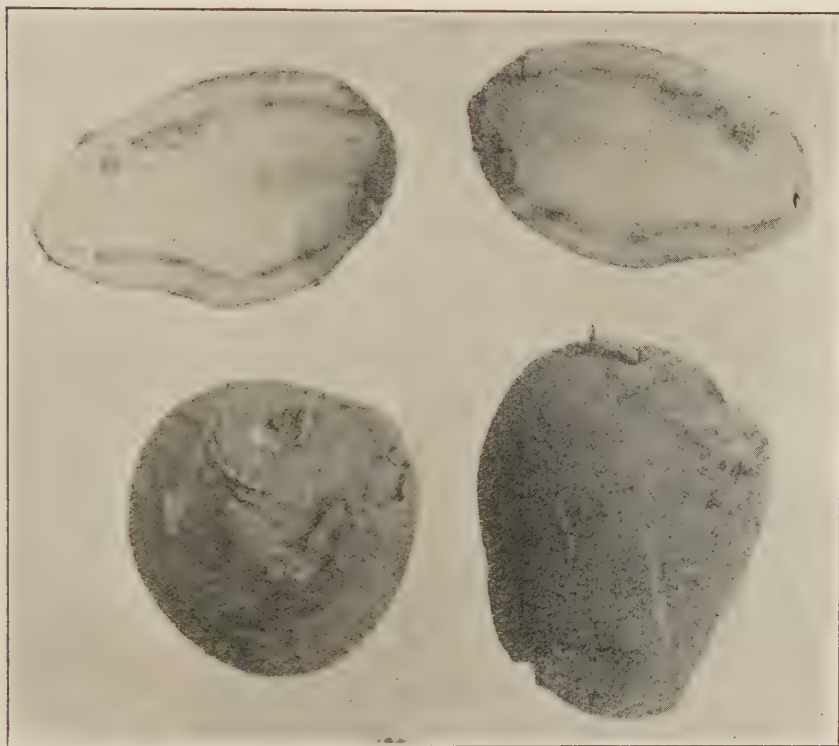


Fig. 12. FUSARIUM ROT.
Note the internal discoloration.

end and just below the peel. This discoloration becomes more noticeable after the tuber has been in storage for some time, and is frequently followed by a dry rot in storage which is sometimes the cause of heavy losses. Soft rots also may develop as a result of infection by other rot organisms. It is through these discolored potatoes that the disease is carried. In the field the diseased plants may wilt and die prematurely; the stems blacken and rot at the surface of the ground and are frequently covered with a white or pinkish fungous growth. If the stem of a diseased plant is cut

across, the fibro-vascular bundles are found to be discolored. This disease may be confused with net necrosis (page 24).

Control. Since the disease is carried in the seed care should be taken to throw out all tubers showing dark discolorations when cut. Rotation of crops also will assist in the control of the disease in that this will prevent the soil from becoming infested with the fungus.

Verticillium Wilt

(*Verticillium alboatrum* Reink.)

This disease also is caused by a fungus and in its symptoms is very similar to Fusarium wilt. The brownish discoloration of the tuber is more pronounced than in the case of Fusarium wilt and the wilting of the plant is much more rapid. It is less common and not so widely distributed as the Fusarium wilt. This disease also may be confused with net necrosis (page 24).

Southern Bacterial Wilt

(*Bacillus solanacearum* E. F. Smith)

This disease, also known as "sleeping sickness", is caused by a bacterium which also attacks tomatoes, eggplants, peppers and tobacco. The first symptom of the disease is a wilting of the plant during the day with a revival at night and a wilting the second day. Plants seldom survive the second day's wilting unless there should be intervening rains; they become yellow and blacken and the tubers rot readily. While the disease is severe in the southern states it is seldom serious in New Jersey, possibly because the cooler weather checks its progress. The disease is usually most severe in dry weather.

Control. Tubers from diseased vines should not be used for seed. Rotation of crops should be practiced, avoiding planting other crops susceptible to the disease.

Potato Scab

(*Actinomyces chromogenus* Gasparine)

Potato scab has long been the cause of serious losses to the potato growers of the country. A study of reports from fourteen of the more important potato-growing states showed that approximately 6,000 000 bushels of the 1919 crop were rendered worthless because of scab, the losses amounting to as much as 25 per cent in some states. There is always considerable scab in New Jersey; during the past year a large number of fields were observed where from 10 to 90 per cent of the crop was so scabby as to be unsalable.

Various opinions are held by the growers as to the cause of scab. Among these might be mentioned weather conditions, manure, fertilizer, lime and grubs. It has been well established, however, that the trouble is caused by one of the higher forms of bacteria,

the development of which is favored by certain conditions of soil and weather. When the soil and seed are free from the organism causing scab a clean crop can be grown regardless of weather or soil conditions.

In appearance this disease varies from a very slight russetting of the tuber to pronounced roughness (fig. 13). In extreme cases the scab areas may extend deep into the tuber, rendering it worthless. In view of the fact that the scab spots are formed by the production of corky tissues the infested tuber is not usually invaded by organisms causing rot to any greater extent than a smooth tuber. The scab spots, however, do permit easy access to wire-worms and white grubs.

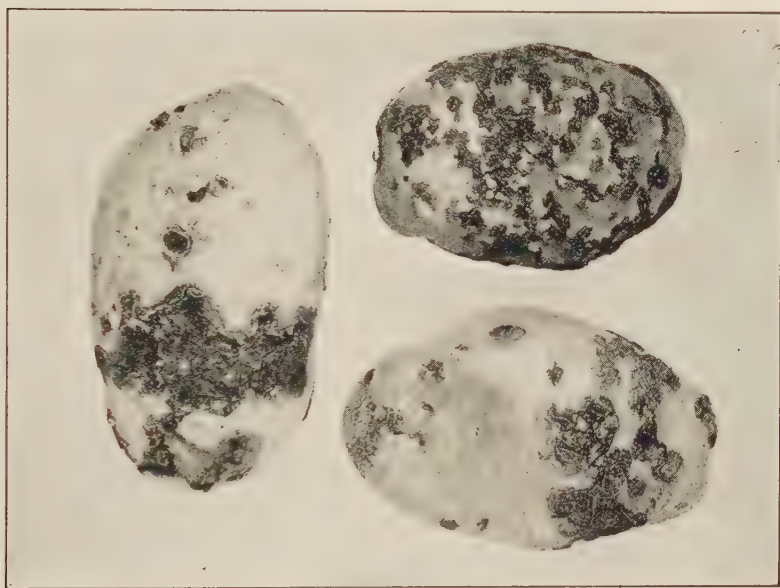


Fig. 13. COMMON SCAB.

The organism causing this disease is carried on the seed, in manure from animals fed on diseased tubers and in the soil. Control measures should be based on planting clean seed. If the seed has been treated with formaldehyde or corrosive sublimate as described on (page 31) a clean crop will result and soil infection will be prevented. If untreated scabby seed is planted on an alkaline soil, not only can a scabby crop be expected but subsequent potato crops are likely to be scabby as a result of the fact that the soil has been infected with the organism. When this occurs the scab organism will thrive in the soil for years; cases have been reported where a scabby crop was grown on land that had not been

planted in potatoes for several years. This same organism will attack beets and turnips and probably other plants.

Control measures. (a) Select clean, smooth seed; (b) treat with formaldehyde or corrosive sublimate; (c) avoid planting potatoes on a scab-infested soil; (d) do not apply lime or other alkaline materials to potato land; (e) maintain the soil slightly acid by the use of acid fertilizers and plowing under green manures; (f) treat land that has grown a very scabby crop with sulfur (page 34).



Fig. 14. POWDERY SCAB.

Powdery Scab

[*Spongospora subterranea* (Walls.) Lang.]

This disease is quite different from common scab but it is difficult for the inexperienced observer to distinguish between the two. Powdery scab is caused by a slime mold. The spots produced are usually smaller than those produced by common scab (fig. 14). The young spots are covered but on maturity break open revealing brownish, powdery masses, the spots being surrounded by the torn skin of the tuber.

This disease was probably introduced from Europe where in some sections it is very severe. It is now found in a number of the northern potato-growing states of this country. While the organism is sometimes brought into New Jersey on seed potatoes it is

very doubtful if it will ever prove serious since experiments made in 1915 and 1916 indicate that it will not develop in the state.

• Black Wart

(*Chrysophlyctis endobiotica* Schib.)

Black wart, is one of the most serious of European potato diseases. On severely infected tubers it causes coral-like scaly nodules that are at first white but later turn brown and then black (fig. 15). These warty growths are usually spongy in consistency. Seed potatoes may be so slightly infected that it is difficult to detect the presence of the disease. These slightly infected tubers are most dangerous for seed purposes.



Fig. 15. BLACK WART.

This serious trouble has already been introduced into this country, being first discovered in the vicinity of Freeland, Luzerne County, Pennsylvania, in 1918. Since this first record of its appearance, it has been found in other sections of Pennsylvania and in West Virginia and Maryland. Fortunately the disease was found in or near coal mining villages and not in the potato-growing sections. Except for the growing of immune varieties there is no known method of control. To prevent its further distribution, the areas in which black wart has been found have been placed under quarantine. New Jersey growers should be on the lookout for this disease, as its occurrence in the state would be a serious menace to the potato-growing industry.

Silver Scurf

(*Sclondylocladium atrovirens* Harz.)

This disease was introduced from Europe. Dark brown spots are produced on the skin and in mild forms may escape the notice of the grower. In storage these spots enlarge, the tubers shrivel and become somewhat silvery in appearance. This disease is occasionally found on seed coming into New Jersey and has also been found in some fields. It does not appear to be a very serious disease for New Jersey growers.

Tuber Rots

In addition to "late blight" or "mahogany rot" and the "dry rot" previously described there are numerous other tuber rots, some of which have been the cause of serious losses. In 1919 there was a heavy outbreak of bacterial soft rot in the commercial crop; this trouble was augmented by warm, wet weather and resulted, in some cases, in very heavy losses. This bacterial soft rot is very frequently associated with the late blight and other rots and is frequently the cause of heavy losses during shipment and in storage.

Occasionally a similar trouble is found on seed brought into the state, resulting in a rapid rotting of the tubers. The soft, slimy pulp, containing millions of bacteria, is smeared over the surface of the sound potatoes in the handling, and some of it may reach the freshly cut seed piece by contact with the potatoes or from the cutting knife. If the cut potatoes stand for a short time before planting, black sunken spots, due to the action of the bacteria, appear on the cut surfaces. If the weather is warm the seed piece sprouts and no great loss results from this rot. If, on the other hand, the weather is cold and wet many of the pieces rot, the result being a poor stand or weak plants.

Control. Although the seriousness of this trouble is largely determined by weather conditions, the loss can be reduced by treating the seed with formaldehyde or corrosive sublimate. When the seed is cut it is well to dip the cutting knives in a 25 per cent solution of formaldehyde. This may be accomplished without loss of time by having two knives for each cutter and letting one stand in the solution while the other is being used.

Black Heart

This condition is familiar to most growers. The interior of the tuber shows an area of dead, black tissue (fig. 16), while the tuber may be normal externally. Black heart may result from several causes. It may be caused by over-heating in shipping or in storage. A temperature of 100° F. will produce this blackening. Tubers subject to insufficient aeration through deep piling also

frequently show black heart. If potatoes are to be stored for several months at a temperature below 45° F., 6 feet should be considered a maximum depth of piling. Proper ventilation in storage will prevent this trouble.

Russet

Russetting of tubers is characteristic of some varieties, but in smooth varieties it is frequently associated with common scab and with *Rhizoctonia*. On the American Giant variety this trouble is sometimes very prevalent and is due largely to the scab organism (page 18).

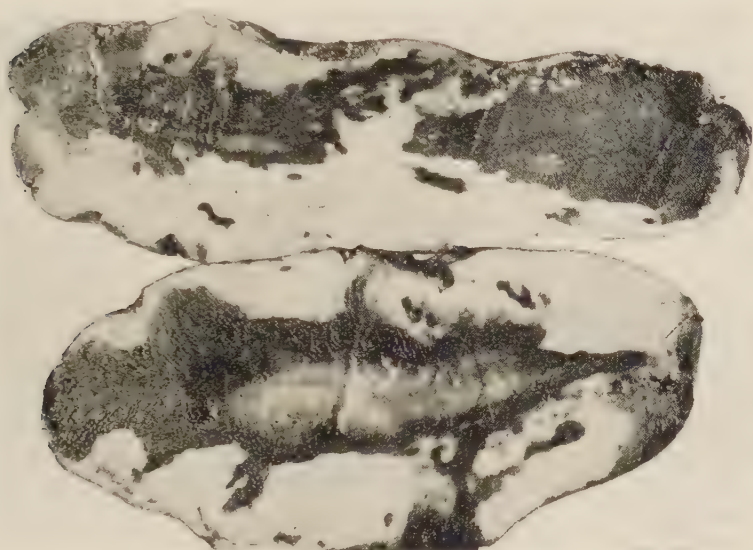


Fig. 16. BLACK HEART.

Hollow Heart

This very familiar condition is due to excessive growth. The splitting or hollow heart no doubt results from unequal growth of different parts of the tuber. The trouble is especially common when excessive rains follow a period of drought. Experiments indicate that it does not injure the tubers for planting.

Spindle Sprout

Very frequently an apparently healthy tuber will produce very slender sprouts. This condition is known as "spindle sprout". Planting seed of this kind results in the production of a small crop and usually the tubers formed are very small. The disease can readily be eliminated from the seed plot with proper attention to roguing. Proper storage also tends to eliminate the trouble.

Net Necrosis

This disease appears as dark brownish zones or streaks in the tuber. These discolorations originate at the point of attachment to the vine and the trouble is sometimes mistaken for *Fusarium* or *Verticillium* wilt. While there is no direct evidence there are some indications that this disease can be transmitted in the seed. Very frequently it cannot be detected at the time of digging but develops in storage.

Lightning Injury

A number of cases of lightning injury have been observed in the state. In one instance the plants in an area of approximately 100 square feet were killed. The plants immediately surrounding this area were brown at the base and gradually died. In some cases one side of the stem for the entire length of the plant was brown (fig. 17). The injured plants continued to die for a week after the spot was first observed, the rapidity of dying being determined by the severity of the injury.

Potato Spraying

What to Spray With

As the result of a large number of potato-spraying tests conducted in various sections of the country the superiority of home-made Bordeaux mixture has been demonstrated over that of the commercial mixtures for the control of late blight and other foliage diseases. Not only is the home-made mixture more effective but it is cheap and easy to prepare. Bordeaux mixture is a combination of copper sulfate and lime in water. The formula commonly recommended for use for potato spraying is the 5-5-50 mixture. This means 5 pounds of copper sulfate, 5 pounds of lime in 50 gallons of water. While weaker mixtures have been used the indications are that this one will give best results. Bordeaux mixture will not control insects except that it will tend to drive the flea beetles away. Where this is necessary it is well to add an insecticide such as arsenate of lead or calcium arsenate and nicotine extracts. The addition of any of these will not reduce the efficiency of either mixture. At least 100 gallons of spray material should be applied per acre. In all spraying operations remember that the points of importance are: (a) the proper mixture, (b) proper machinery, (c) pressure, (d) sufficient nozzles and (e) proper nozzle adjustment.

Preparation of Bordeaux Mixture

If only a small acreage is to be sprayed the mixture may be prepared as needed. Dissolve 5 pounds of copper sulfate in hot water; when completely dissolved make up to 25 gallons. In an-

other container slake 5 pounds of lime and add water to bring the total up to 25 gallons. These two may then be poured together into the spray tank. The spray tank should be equipped with a

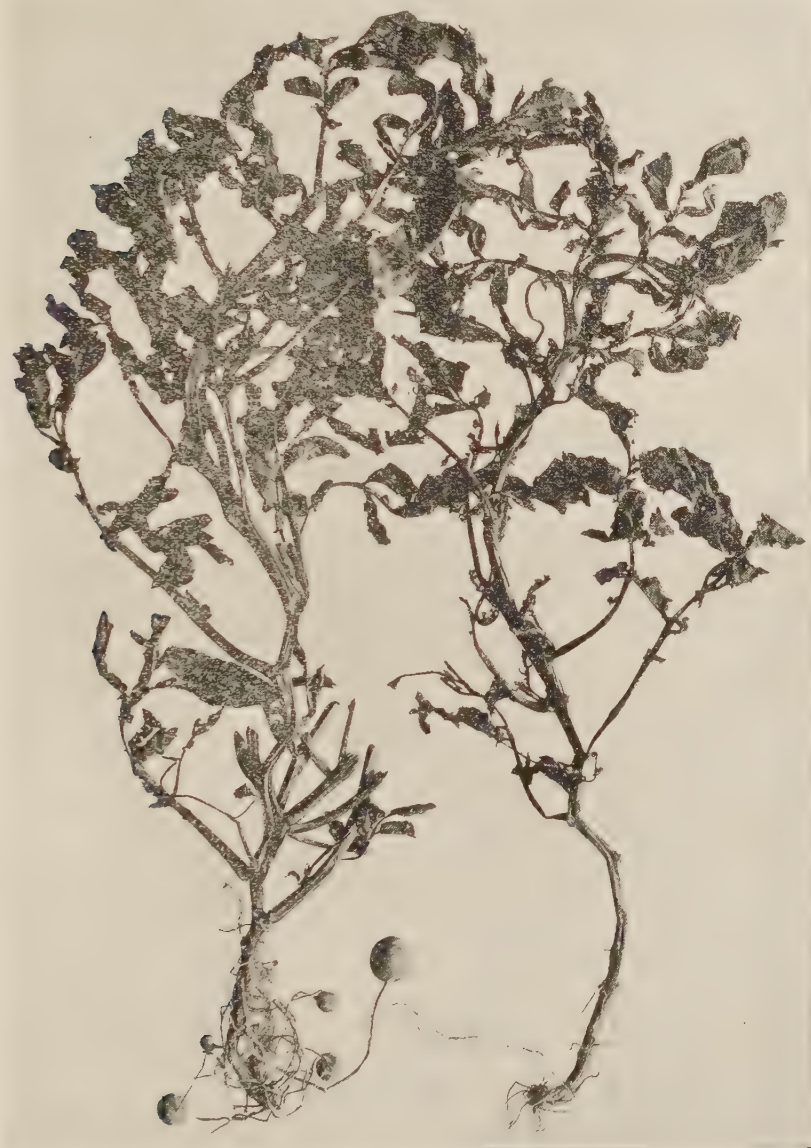


Fig. 17. LIGHTNING INJURY.
Note injury at base and extending along vine.

good strainer; failure to strain the lime-water will frequently result in considerable trouble through the clogging of the nozzles.

When spraying is done on a large scale it is well to make up stock solutions of copper sulfate and lime. In a separate vessel slake 50 pounds of lime and when it is thoroughly slaked add enough water to make the total up to 50 gallons. In another barrel suspend 50 pounds of copper sulfate in a burlap bag in 50 gallons of water. Adjust the bag so that it is suspended just beneath the surface of the water. When using the stock solutions 1 gallon represents 1 pound of the material in question. To make 100 gallons of a 5-5-50 mixture in a 100-gallon spray tank, add 10 gallons (pounds) of the copper sulfate solution while the water is being run into the tank. When the tank is three-quarters full and with the water still running, add 10 gallons (pounds) of the lime-water. When this has been done the tank is filled and the mixture is ready to apply. In making Bordeaux mixture, never pour the undiluted materials together. Always dilute one or both. If insects are numerous it is well to add calcium arsenate or arsenate of lead at the rate of 4 to 6 pounds of the powder to 100 gallons of Bordeaux. For best results all spray applications should be made at the rate of 100 gallons per acre.

Does Spraying Pay?

Extensive spraying tests conducted in New York and New England have demonstrated that the use of Bordeaux mixture pays. Marked increases have been obtained in Maine and Vermont even in years when there was no late blight. As a result of a series of tests conducted over a period of 10 years the New York Agricultural Experiment Station found an average increase of 97.5 bushels per acre as a result of from 5 to 7 applications and an increase of 69 bushels from three applications. In 1920 the losses in New York alone from late blight amounted to \$4,000,000. Most of this loss could have been prevented by spraying with Bordeaux mixture. In New Jersey this disease has not been the cause of serious loss. In view of the fact, however, that it has been more abundant the past three years than it was the six preceding years, it is possible that the growers may be compelled to spray.

In 1913 the New Jersey Agricultural Experiment Station started tests to determine whether or not potato spraying is advisable under New Jersey conditions. In 1913 the work was conducted by the senior author and G. W. Martin cooperating; in 1914 Dr. T. J. Headlee and A. E. Cameron cooperated. Dr. H. C. Lint cooperated in 1915 and 1916, R. F. Poole in 1917 and Dr. L. M. Massey in 1918. The work in 1919 and 1920 was in charge of the junior author. A summary of the results is here presented.

In table 1 is given the results of tests conducted with the Irish Cobbler variety, commercial crop. A study of this table shows that

TABLE I
RESULTS OF EIGHT YEARS' SPRAYING EXPERIMENTS WITH THE
IRISH COBBLER VARIETY
(COMMERCIAL CROP)

Year	Spray Used	Dates of Spraying	Yield per Acre	Remarks
			bu.	
1913	Lead arsenate	May 27, June 11, 20	340.0	Colorado beetle and flea beetle abundant May 6.
	Bordeaux,			
	Paris green	July 5.	315.0	
	Kil-tone		299.0	Early blight common in all plots July 10. Considerable amount of tip burn and spray injury on Bordeaux plot.
	Pyrox		327.0	
1914	Lead arsenate	May 21, June 1, 10, and 24.	212.7	Considerable flea beetle injury early in the season.
	Bordeaux,			Very slight infection of
	lead arsenate		275.6	early blight.
	Kil-tone		214.5	
1915	Lead arsenate	May 26.	248.6	Treatments not repeated.
	Bordeaux	June 9, 22, 30.	288.3	Vines turned yellow about July 1, followed by wilting.
	mixture			Less severe on Bordeaux
	Tonicide		254.6	plots.
1915	Lead arsenate	May 17, June 1, 24,	393.7	A few scattered infections of early blight when the vines started to die.
	Bordeaux,		389.1	
	lead arsenate			
	Kil-tone	July 2.	395.0	
1916	Lead arsenate	May 27, June 6, 17 and 29.	376.7	O. K.
	Bordeaux,			
	lead arsenate		385.8	
	Pyrox		373.8	
	Kil-tone		386.6	O. K.
	Tuber tonic		342.1	O. K.
1916	Lead arsenate	June 1, 12, 19, 28.	230.8	Uniform stand, tubers of excellent quality.
	Bordeaux,			
	lead arsenate		235.2	
	Hydroxide			
	(Proprietary			
	Bordeaux)		229.5	
	Kil-tone		192.5	

TABLE 1 (Continued)

RESULTS OF EIGHT YEARS' SPRAYING EXPERIMENTS WITH THE
IRISH COBBLER VARIETY
(COMMERCIAL CROP)

Year	Spray Used	Dates of Spraying	Yield per Acre	Remarks
1916	Lead arsenate	May 25.	259.0	
	Bordeaux,			
	lead arsenate Kil-tone	June 5, 12, 26.	276.1 227.9	
1917	Lead arsenate	3 applications	175.2	
	Bordeaux, lead arsenate		178.5	
1917	Lead arsenate	2 applications	313.3	
	Bordeaux,			
	lead arsenate Kil-tone		309.1 316.3	
1918	Lead arsenate	May 27.	237.0	Slight amount of early blight.
	Bordeaux,			
	lead arsenate	June 5, 15.	228.0	All plots affected alike.
	Adheso Tiger brand (Bordeaux-lead)		224.0 217.0	
1918	Lead arsenate		271.0	
	Bordeaux,		294.0	
	lead arsenate Kil-tone		294.0	
1919	Lead arsenate	May 31.	216.0	Heavy infestation of early blight and tip-burn. Plots sprayed with the copper mixtures showed less than half as many dead leaves as check plots.
	Bordeaux,			
	lead arsenate	June 10, 17, 27.	265.3	
	Bordeaux,	July 7.	268.6	
	zinc arsenate			
1920	Lead arsenate	June 8, 18, 29.	260.3	August 3, 98 per cent of leaves on check plots dead as compared with 76 per cent and 70 per cent for the 5-5-50 and 4-4-50 mixtures, respectively.
	Bordeaux (5-5-50)			
	Lead arsenate	July 9, 22.	281.8	Dying of leaves due largely to tip-burn and early blight.
	Bordeaux (4-4-50)		266.0	
	Lead arsenate			

late blight was not a factor in any of these tests and that in only three was there any great amount of early blight recorded. In table 2 are presented the results of tests with home-made Bordeaux mixture and arsenate of lead. Of the thirteen conducted, nine gave positive and four negative results. The average yield of the check plots, treated with arsenate of lead, was 271.8 bushels per acre as compared with an average yield of 284.7 bushels per acre recorded for the plots sprayed with Bordeaux mixture, an increase of 12.9 bushels in favor of the spray treatment.

Tests with the American Giant Variety

Negative results were obtained as the result of spraying tests conducted over a period of 5 years with the American Giant variety. These data are presented in table 3. It will be seen that with these tests, as was true of those conducted with the Irish Cobbler variety, late blight was not a factor. It will also be noted that there were only slight infections of early blight and very little tip-burn in the fields in which this work was conducted. The average yield of plots sprayed with Bordeaux mixture was 307.9 bushels per acre as compared with 318.0 bushels recorded for the check plots, sprayed with an insecticide, an increase of 10.1 bushels in favor of the latter treatment. It is believed that this failure of the American Giant

TABLE 2

YIELDS SHOWING INCREASE OR DECREASE OF PLOTS SPRAYED
WITH HOME-MADE BORDEAUX MIXTURE OVER ADJOINING
CHECK PLOTS
(COBBLERS)

Year	Arsenate of Lead	Bordeaux Mixture and Arsenate of Lead	Gain	Loss	Number of Applications
	bu.	bu.	bu.	bu.	
1913	340.0	*315.0	---	15.0	4
1914	212.7	275.6	62.9	---	4
1915	248.6	288.3	39.7	---	4
1915	393.7	389.1	---	4.6	4
1916	376.7	385.8	9.1	---	4
1916	230.8	235.2	4.4	---	4
1916	259.0	276.1	17.1	---	4
1917	175.2	178.2	3.3	---	3
1917	313.3	309.1	---	4.2	2
1918	237.0	228.0	---	9.0	3
1918	271.0	294.0	23.0	---	--
1919	216.0	265.3	49.3	---	5
1920	260.3	281.8	21.5	---	5
Average	271.8	284.7	12.9	---	--

*Paris green.

to respond to the Bordeaux mixture may be due to varietal differences. This belief is strengthened by the fact that in a test conducted in 1916, where these two varieties were planted side by side, the Cobblers showed an increase of 17.1 bushels per acre as a result of spraying with Bordeaux mixture while with the American Giant variety the same mixture gave a decrease of 10.0 bushels over adjoining check plots.

Spraying Tests with the Late Crop

The late crop, grown for seed purposes, is planted about August 1. As a result of the short growing season it is usually killed by frost, and does not mature. The results of tests conducted over a period of 5 years are shown in table 4. In 1919 there was a severe outbreak of late blight and four applications of Bordeaux mixture gave an increase of 47.7 bushels per acre over adjoining

unsprayed rows (fig. 18). In 1915, 1916, and 1917 there was no late blight but in the latter year there was considerable tip-burn. The slight differences recorded for these three years may no doubt be accounted for by the fact that late blight was not present and that the number of applications was limited to two and three.

TABLE 3
RESULTS OF FIVE YEARS' SPRAYING TESTS WITH THE AMERICAN GIANT VARIETY
(COMMERCIAL CROP)

Year	Spray Used	Date of Spraying	Yield per Acre	Remarks
1914	Lead arsenate	May 21, June 5, 16, 27.	bu. 283.4	Slight infection of early blight, late in season. No differences in vine growth on various plots.
	Bordeaux,			
	lead arsenate		286.1	
	Ansbacher's Bordeaux-Lead		282.0	
1915	Paris green	3 applications	408.0	The stems on the plots sprayed with Bordeaux mixture remained greener than those on the other plots.
	Bordeaux, lead arsenate		411.0	
1916	Lead arsenate	June 5, 12, 20	377.7	
	Bordeaux,		367.7	
	lead arsenate		348.4	
	Kil-tone			
1919	Lead arsenate	May 27	262.8	Tip-burn and early blight appeared after June 5. Late in the summer the arsenate of lead plots were better than those sprayed with Bordeaux.
	Bordeaux,			
	lead arsenate	June 5, 12	228.3	
	Calcium arsenate		227.2	
1920	Paris green	July 20	235.1	
	Lead arsenate	June 10, 25	258.3	
	Bordeaux,			Some early blight and tip-burn, sprayed plots little better than unsprayed.
	lead arsenate	July 2, 10, 20	246.8	

In 1920 a test was conducted with the Irish Cobbler and American Giant varieties planted in the same field. Late in the season the vines of the check plots were killed by late blight. In this test the increase recorded for the American Giant variety was almost as great as that recorded for the Cobblers, being 22.9 bushels per acre for the former and 27.6 for the latter. It is evident from this that in case of an outbreak of late blight, spraying with Bordeaux mixture pays regardless of the variety.

In the tests with the Irish Cobbler variety the average yield for the 5-year period was 150.4 bushels for the check plots as compared with 178.0 bushels for the plots sprayed with Bordeaux mixture. In many instances the grower will not spray unless assured

that increased returns will result. In the growing of the late crop the yield is of secondary importance, the vitality of the tuber for seed purposes being the primary consideration. In view of the average increase of 22.9 bushels recorded for a period of 5 years and the fact that the dying of the vines may be delayed several weeks or longer, it is doubtful if the grower of late-crop seed potatoes can afford not to spray.



Fig. 18. Late Blight Controlled by Four Applications of Bordeaux Mixture.

Seed Treatment

Seed treatment for the control of scab and scurf (*Rhizoctonia*) has been recommended for a number of years but the practice has not been generally adopted in the state. In some instances seed treatment has been omitted because failure resulted from previous attempts. Very often this has resulted from the fact that the treated seed was planted on scab-infested soil. When this occurs, seed treatment will be of some value but a clean crop cannot be insured. A few cases of injury have been reported, which have usually been due to either treating after the sprouts are formed, using too strong a mixture, allowing the potatoes to remain too long in the solution or treating after the seed is cut.

The principal reason, however, for the failure to adopt seed treatment lies in the fact that the practice requires both time and labor. In the past the recommendations for seed treatment have been to soak the tubers for $11\frac{1}{2}$ hours. Since the length of time period has deterred the average grower from treating seed, tests were conducted in 1919 to determine if this could be reduced without loss of efficiency. Both formaldehyde and corrosive sublimate

TABLE 4
RESULTS OF FIVE YEARS' SPRAYING TESTS WITH IRISH COB-
BLER AND AMERICAN GIANT VARIETIES
(LATE-CROP)

Year	Spray Used	Date of Spraying	Yield per Acre	Remarks
1915	Lead arsenate Bordeaux mixture	Aug. 23, Sept. 8 Sept. 24	bu. 236.7 248.6	
1916	No spray Lead arsenate Bordeaux, lead arsenate Kil-tone		154.7 151.0 163.5 164.8	
1917	Unsprayed Bordeaux, lead arsenate Kil-tone	2 applications	210.5 217.5 224.1	Plants free from disease in the early portion of the season. In July heavy rains and warm weather brought on a severe outbreak of tip-burn followed by early blight.
1919	Unsprayed Bordeaux mixture	Sept. 12, 19, 29 Oct. 9	132.6 180.3	At the time of the fourth application 75 per cent of the leaves of the check plots were infected with late blight, only a trace on the sprayed plots.
1920	Unsprayed Lead arsenate Bordeaux mixture	Sept. 8, 17, 27 Oct. 7, 18	163.9 175.2 199.3	Considerable early blight and tip-burn, some late blight on October 18. Condition of vines, unsprayed plots 94 per cent dead, lead arsenate 68 per cent, Bordeaux 9 per cent.
1920	Unsprayed *Bordeaux mixture	Sept. 8, 17, 27 Oct. 7, 18	150.4 178.0	Leaves dead on October 18, check 62 per cent; Bordeaux plots 12 per cent; largely the result of late blight. No insects present in the field in which the last two experiments were conducted.

*American Giant variety.

were used, the solutions being made up according to the recommendations given below for their preparation. In all there were four treatments, as follows: 1 hour, 30 minutes, 15 minutes and sprinkling. The results of the tests are given in table 5 (fig. 19).

The results of these tests may be summarized as follows:

1. Seed treated with either corrosive sublimate or formaldehyde gave a better stand than untreated scabby seed.

2. The formaldehyde treatment for $\frac{1}{2}$ hour gave a greater increase in salable primes than the 1-hour treatment.

3. The corrosive sublimate treatment for 15 minutes gave a greater increase in the number of salable primes than the 1 or the 1½-hour treatment.

4. The 1-hour treatments with corrosive sublimate gave slightly better control of scab than the shorter treatments.

5. Soaking the seed for 15 minutes in either solution gave very good control of scab as well as a marked increase in salable primes over the check plots.

TABLE 5
EFFECT OF TREATING SEED TUBERS WITH DISINFECTANTS ON
YIELD AND SCAB CONTROL

Treatment	Yield per Acre	Per cent Scabby in Primes
Formaldehyde—	bu.	
1 hour	147.4	18.4
½ hour	175.3	17.9
¼ hour	158.9	30.2
Sprinkled	146.4	29.4
Corrosive Sublimate—		
1 hour	178.6	17.2
½ hour	148.3	26.6
¼ hour	184.5	21.3
Sprinkled	174.7	31.4
Check	145.6	43.9

While the seed used in these tests was scabby there is no question as to the advisability of seed treatment. The results of a large number of tests conducted in many parts of the country have demonstrated that it pays. Of the two solutions recommended for this purpose corrosive sublimate will give the better results, since it will control both scab and scurf. The directions for the use of these two solutions are as follows:

Corrosive sublimate (Mercuric chloride).....4 ounces
Water 30 gallons.

Treat ½ hour.

Hot water should be used to dissolve this material. As the solution corrodes metal it must be prepared and used in wooden containers. Corrosive sublimate is a *deadly poison*, so the solution as well as the potatoes treated in it should be kept away from children and livestock. Since this solution loses strength rapidly, it is necessary to renew it from time to time. The best plan to follow is to add 1 ounce of dissolved corrosive sublimate to each barrel together with enough water to bring the solution up to original volume, after each lot of potatoes has been treated. When this has been done four times, use twice and then throw away the old solution and prepare a new one.

Formaldehyde1 pint (pound)
Water30 gallons.

Treat ½ hour.

Formaldehyde does not lose strength on standing but tends to grow stronger, resulting from the fact that the water evaporates faster than the formaldehyde. This solution may be used eight or ten times without renewal.

A convenient method for the use of either of these solutions is to suspend the potatoes in a bag in the solution, allow them to remain there for $\frac{1}{2}$ hour and remove. After the potatoes have been treated spread them out in a thin layer so that they may dry as soon as possible. If they do not dry promptly, the result is the same as prolonged soaking and may result in poor germination.

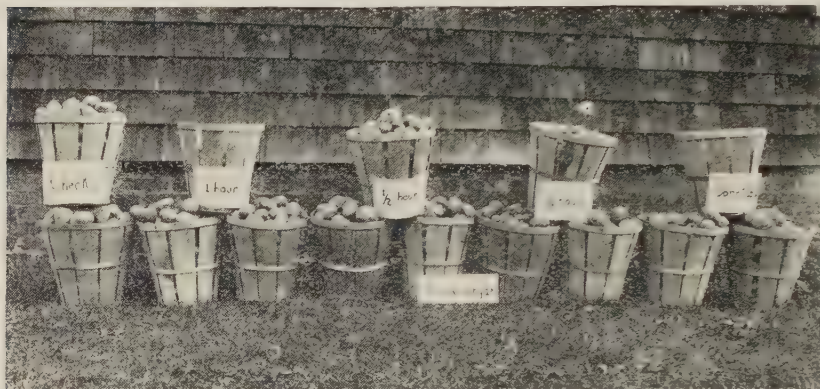


Fig. 19. RESULTS OF TREATING SEED POTATOES WITH FORMALDEHYDE
(Table 5)

The practice of dusting cut potatoes with sulfur, gypsum, slaked lime, etc., is quite common among many of the growers in the state. The use of any of these materials results in the more rapid formation of an artificial skin, thus reducing the amount of water lost from the seed piece. Of these materials sulfur is probably the best, since it possesses stronger fungicidal properties than any of the others.

Sulfur For Scab Control

It is recognized that scab is usually most severe on an alkaline soil and that as the soil acidity increases the severity of the scab attack decreases. Since this is true it will readily be seen that there are certain fertilizers or chemicals which when added to the soil will tend to increase the amount of scab while certain others will so change the soil reaction as to prevent its development. The influence of some of the more common materials applied to the soil may be summarized as follows:

Barnyard Manure. An application of barnyard manure just before potatoes will lead to a marked increase in the amount of scab, the increase, in general, being in proportion to the rate of application. Fresh manure is apparently more likely to be injur-

ous than old or composted manures. Applications of manure should be made on other crops in the rotation, rather than immediately before or on the potato crop.

Lime. Lime also has been found to favor the development of scab, and applications of lime are not to be recommended on the potato crop. The best time to apply lime in a potato rotation is on the crop following potatoes.

Wood ashes. This material is but little used at present. Its use should be avoided on potatoes, as it favors the development of potato scab to a marked extent.

Sodium nitrate. This material if used in large amounts would eventually favor the development of scab. However, the quantity used is so small that no serious increase in the amount of scab will follow its use.

Other chemicals. Ammonium sulfate, kainit, acid phosphate, sulfate and muriate of potash are materials which applied as fertilizers would tend to maintain the soil sufficiently acid to inhibit the development of the scab organism.

Cover Crops. In connection with the use of acid fertilizers the plowing under of a green manure such as rye, grass or clover sod, also will tend to maintain the soil reaction so as to reduce the growth of scab.

Where the soil has become alkaline from applications of lime or other substances of a similar nature and where the scab organism has become well established it is very questionable if any of the above measures will give the desired results. Where conditions of this kind exist some other means must be taken to change the soil reaction from alkaline to acid. As early as 1895 Dr. B. D. Halsted of the New Jersey Agricultural Experiment Station started work to determine if there was not some substance that could be added to the soil that would accomplish this. As the result of testing a large number of materials he found sulfur to be the only one to give results. In 1913 Dr. H. C. Lint of the department of plant pathology took up this work and his studies extended over a period of four years. In 1918 the work was resumed by the junior author. The results of this work may be summarized as follows (fig. 20) :

Kind of sulfur. The finely ground commercial sulfur known as *sulfur flour* should be used. Studies recently conducted have shown that better results follow if this material has been inoculated with sulfur-oxidizing organisms. The coarser material will not give satisfactory results and flowers of sulfur is too expensive.

Time and method of application. The applications should be made broadcast after the land is harrowed and just before planting. A lime distributor may be used but a grain drill will give best results as the sulfur will be more uniformly distributed and at the same time will be mixed with the surface soil.

Rate of application. The amount of sulfur to be used should be determined largely by the alkalinity of the soil. Where this is impossible the rate of application should be determined by the amount of scab in the crop the previous year. From the results obtained in 1919 it was apparent that where a large portion of the crop was unsalable an application of from 500 to 600 pounds per acre was by no means too heavy. Where only a few are unsalable but the remainder quite scabby from 400 to 500 pounds may be used. Where the crop is all salable but quite scabby the application should be limited to 300 to 400 pounds.



Fig. 20. UNSALABLE SCABBY TUBERS FROM PLOTS RECEIVING NO SULFUR AND FROM PLOTS TREATED WITH 400 AND 600 POUNDS OF SULFUR

Influence of variety. For a number of years the growers of the American Giant have maintained that this variety will not scab to the same extent as round stock. While this is no doubt true, the Giant cannot be said to be immune. Fields were observed in 1920 where as much as 75 per cent of the crop was unsalable. It is apparent from this that all of the varieties grown in this state are susceptible to this disease. •

Home-Grown Seed

It is only in recent years that the New Jersey growers have adopted the practice of growing their own seed. Two methods are commonly followed. The first and least practiced, is to harvest tubers immature from the commercial crop. As the result of tests conducted in 1919 it was demonstrated that the best time in the development of the potato to dig seed immature was when approximately 50 per cent of the leaves were dead. In harvesting this seed, care must be taken to select healthy plants. If only a limited amount is desired the best procedure will be to select vigorous hills and dig them by hand. If a considerable acreage is to be harvested immature the field should be inspected several times during the

growing season and all diseased hills removed. The remaining healthy hills may then be dug. If the proper precautions are taken in selection and in storing the tubers after they are dug this method insures a source of seed that is relatively free from disease and of high vigor.

In the southern counties the practice of holding seed in storage during the early summer and planting the last week of July or the first of August has been generally adopted. The tubers so planted develop in the cool of the summer and are usually killed by frost before reaching maturity. This approximates conditions under which seed potatoes are produced in the northern potato-growing sections and has proven to be a reliable source of high-grade seed for the New Jersey buyer. Two methods are followed in growing this crop. (a) Some growers hold northern seed in storage until July or August when it is planted. The crop thus produced is held until the following spring and planted for the early crop. (b) Most of the growers, however, have developed their own strains and plant the same seed year after year. Field studies have shown that this seed matures from one to two weeks later than northern seed but that there are usually fewer missing hills and much less of certain diseases.

Seed Improvement

While the practice of growing seed potatoes in New Jersey has been in vogue for comparatively few years a standard has been set that enables Jersey-grown seed to compete with that from other sources. The growers of late-crop seed should endeavor to maintain the present standards, omitting nothing that will lead to increased vigor and productiveness. Possibly the best method of accomplishing this is through the maintenance of a seed-improvement plot. Every grower of seed potatoes should maintain a seed plot large enough to supply sufficient seed potatoes for the succeeding year (fig. 21).

The plot should be inspected at least twice during the growing season; the first inspection being made when the plants are about 6 to 8 inches in height and the second as late as possible so as to eliminate a maximum of disease and all plants not true to variety and type. In doing this it should be kept in mind that the tubers as well as the top must be removed. Particular care should be taken to eliminate all plants affected with mosaic or leaf-roll since either of these diseases will result in reduced yields.

The seed plot should be thoroughly sprayed for the control of insects and such diseases as early and late blight.

Care must be taken in harvesting and storing the potatoes from the seed plot to prevent bruises and cuts, since a cut or bruised potato rots very readily. It is well to harvest enough seed by hand

to plant the seed plot the following year, selecting only high-yielding, vigorous hills for this purpose.

If the method briefly outlined above is followed the growers of seed potatoes can easily maintain their present standards and in many cases the present strains can be improved.



Fig. 21. LATE-CROP SEED.
Vigorous and relatively free from disease.

Certification of Seed Potatoes

During the past few years some of the seed-producing states have endeavored to establish a system of inspection and certification that not only is of value to the grower in assisting him in the production of high-grade seed but at the same time protects the interests of the buying grower. Growers wishing to improve their seed enter their fields for certification in a manner provided by the officials in charge of the work. The fields are inspected during the growing season, when the plants are about 6 to 8 inches in height and again as late as possible before they die. The crop is inspected, after digging, for diseases which do not show on the parts above ground. This seed must conform to a certain standard of vigor, freedom from disease and trueness to type in order to be certified. Such seed is sold in sealed bags, each bag carrying a card of inspection. In view of the fact that the expense of the inspection is partly borne by the grower, the cost of the seed to the buying grower is somewhat higher than that of ordinary seed. The increased yield resulting from the use of certified seed should more than compensate for the added cost.

In 1918 the New Jersey State Potato Association in cooperation with the State Department of Agriculture inaugurated a system of certification. While this has been in force but two years much good has resulted and the buyers of seed potatoes have learned the value of certification. The rules and regulations for this service may be obtained from the State Department of Agriculture, Trenton, N. J.

Maine, New York, Vermont, Michigan, Wisconsin, Minnesota, and other seed-producing states also have regulations governing the inspection and certification of seed potatoes. Growers desiring to procure seed from any of these states can obtain the necessary information concerning inspection and certification by writing the authorities in charge of the work.

